The Kenai Peninsula as seen from outer space

by Lee O'Brien

The Kenai National Wildlife Refuge is using space age technology to monitor the status of landscapes on the Kenai Peninsula. We have begun an on-going project using satellite images to map land cover and monitor changes over time.

In 1972, NASA launched its first of seven Landsat satellites. Two of the satellites, Landsat 5 and Landsat 7, still continually orbit the Earth, recording images of its surface. It takes one satellite 16 days and 233 orbits to cover the entire Earth. Landsat 7, launched in 1999, records more wavelengths at a higher resolution than Landsat 5, which was launched in 1984. The images from both satellites are downloaded at the U.S. Geological Survey (USGS) EROS Data Center (EDC) in Sioux Falls, South Dakota.

The images from these satellites do not just include the colors we can see - they also include near infrared and thermal infrared wavelengths. Just like with digital cameras, images from satellites are collections of pixels. One pixel in a Landsat satellite image represents a 30m by 30m (98ft x 98ft) square of the Earth's surface. Each pixel stores a set of values for the light reflection at different wavelengths (blue, green, red and infrared) for that spot on the ground. This set of values is called the pixel's spectral signature. Pixels with similar spectral signatures can be grouped together so that, in theory, they represent some feature on the Earth's surface, like a stand of aspen trees, or a parking lot.

The Refuge has acquired four Landsat 7 satellite images that cover the entire Kenai Peninsula. Ideally these images would all be from the same day from a single pass-over of the satellite. However, this is not very likely since there is often cloud cover over some portion of the peninsula on any given day. Also, certain times of the year are better for taking pictures than others. Images taken in February are pretty uniformly white. You want pictures when distinctions between land cover features are easiest to discern. Spring and fall are usually the best.

To get images from a Spring or Fall day without a single cloud over the peninsula at the precise time when the satellite goes over (once every 16 days) is not a frequent occurrence. The images we are using for this land cover classification were obtained in July of 2002. The satellite passed over the west side of the peninsula and took three images (from north to south) with only a few small puffy white clouds. Two days later the satellite past over again and captured the northeastern portion of the peninsula with just some clouds over the islands and peninsulas in Prince William Sound. This image is darker though than the earlier one, which makes it difficult to match up pixel signatures.

Once you have picked out which dates you want and stitched together the relatively cloud-free images into one large image, you have a nice color picture of the Kenai Peninsula from outer space. Except as a wall hanging, this is not much use in and of itself. The next step is to figure out what different land cover features are represented in the image.

There are software programs that can look across all the pixels in the image and group them into a number of similar spectral signatures. Once you have the pixels grouped, you have to put labels on the groups. Sometimes this is easy. One particularly large group of pixels looks a lot like Skilak Lake. You can label this group "lake" and all the other pixels on the image with similar spectral signatures will get labeled as lakes.

Another group of pixels may look strikingly like the Fred Meyer parking lot. You label these pixels "concrete" or "urban." So far, these land cover features, along with "glaciers" and "exposed rock" are pretty easy to classify. It becomes difficult when you try to tell the difference between black spruce, white spruce and hemlock. Or birch, aspen and alder. To do this you have to go out on the Earth's surface yourself, stand in the middle of a patch of alder, or aspen, or hemlock, and record your location using a GPS receiver. This gives you an exact location based on calculations from another set of satellites orbiting the earth. You then map that exact location on your geo-rectified Landsat image and tell it that the group of pixels at that location is a stand of hemlock. You do this many times over and "train" the image to recognize pixels with a certain spectral signature to be a particular land cover feature. If all goes well, you then have a map of all land cover features.

We have just finished a draft version of a map of the land cover features of the Kenai Peninsula. This map makes an even nicer wall hanging. Its main purpose, however, is as a tool describing the peninsula landscape, and to be able to track changes over time with future images. Besides letting us know how much of each land cover type there is and where they are located, we can compare this map to maps from the past and ones created in the future to detect changes like wetland drying, glacier retreat and advancing tree lines, as expected with a warming climate. We can also predict fire behavior in different land cover types, and we can see the effects of previous fires on the landscape. We can locate and monitor wildlife habitat, to answer questions like: Is the habitat for moose increasing, decreasing or remaining constant.

With the availability of continuous satellite imagery and the software to classify it into land cover maps, we can closely monitor a large area like the wildlife refuge, or the entire Kenai Peninsula, keeping an eye on landscape changes from outer space.

Lee O'Brien is a wildlife biologist/GIS specialist at the Kenai National Wildlife Refuge. He has a masters degree in Landscape Ecology. GIS is a computer application used to manage and analyze spatial data, and stands for Geographic Information System, or Geeks In Sandals, depending on who you ask. Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.